

- 14 -

CLAIMS

1. Remotely actuated robotic wrist, **characterised in that**
it comprises:
 - at least a distal element;
 - 5 - an orientable support integral to said distal element;
 - a fixed member having a pivot about which said support is capable instantaneously to rotate;
 - remote means with respect to said distal element
 - 10 for creating at least two independent forces suitable for causing said support to move with respect to said pivot according to at least two independent directions;
 - deviating means said at least two forces so that
 - 15 they are applied to said support according to two predetermined positions.
2. Robotic wrist according to claim 1, wherein said support is capable instantaneously to rotate with respect to said fixed pivot so that said support has
- 20 at least two degrees of freedom with respect to said fixed pivot .
3. Robotic wrist according to claim 1, wherein said at least two forces are applied to said support through means selected from the group:
 - 25 at least one pulling element, in particular a tendon.
 - at least one stiff stick in order to act as pulling element and as pushing element.
4. Robotic wrist according to claim 2, wherein, said support can rotate with respect to said fixed pivot
- 30 according to three degrees of freedom, three pulling elements being provided for applying three respective forces.
5. Robotic wrist according to claim 5, in which said three degrees of freedom of the support are obtained

- 15 -

in a redundant way, with four pulling elements for applying four respective forces.

6. Robotic wrist according to claim 5, wherein said deviating means said or each force comprise:

5 - a base, from which said pivot extends, said base being integral to said support, and
 - a connecting arm between said base and said or each pulling element, the connecting arm being suitable for arranging said pulling element according to a
10 predetermined inclination with respect to said support.

7. Robotic wrist according to claim 5, wherein said or each connecting arm has a first end connected to said base in order to provide a resilient hinge and a
15 second free end connected to a point of said pulling element, whereby when the pulling element moves for actuating the support, the free end of the arm rotates with respect to the first end constraining said point on a circular trajectory.

- 20 8. Robotic wrist according to claim 6, where the first end of said or each connecting arm is hinged to said base by a means selected from the group: a flexible lamina; a hinge and a resilient element.

- 25 9. Robotic wrist according to claim 1, where the rotating connection between said support and said fixed pivot is effected by a ball joint.

- 30 10. Robotic wrist according to claim 9, wherein said pivot has a spherical housing in which a spherical portion integral to said support is housed with freedom of movement.

11. Robotic wrist according to claim 9, wherein said support comprises at least one means of interposition between said distal element and said pivot a portion of which can be deformed in a controlled way with a

- 16 -

predetermined combination of forces in order to bring the fixed pivot to contact means for opening/closing said instrument thus causing the opening/closing of said instrument.

- 5 **12.** Robotic wrist according to claim 1, wherein said means for opening/closing said instrument comprise an articulated mechanism having flexible elements.
- 10 **13.** Robotic wrist according to claim 1, comprising a mechanism equivalent to two spheres, or portions of sphere, rolling on each other, wherein said fixed pivot is located at the centre of the first ball and said deviating means provide an arm rotatable about said pivot and connected to the centre of the second sphere, as well as provide said rolling contact
- 15 between said spheres.
- 20 **14.** Robotic wrist according to claim 13, wherein said mechanism equivalent to two spheres, or portions of sphere, rolling on each other is obtained composing together first and second deviating means comprising each a first and a second kinematical chain comprising each a plurality of stiff elements connected by means of pivot joints and a couple of gears that operate in combination with said first and second kinematical chain.
- 25 **15.** Robotic wrist according to claim 14, wherein said mechanism equivalent to two spheres is obtained replacing said two couples of gears with a tern of stiff elements interconnected by means of pivot joints.
- 30 **16.** Device for teleoperation by means of manipulators "slave" remotely actuated by an operator **characterised in that** it comprises a robotic wrist according to the previous claims operatively connected by said means for applying said at least two forces, located in said

- 17 -

support element having elongated hollow shape, to at least one means for generating said forces.

- 5 17. Device according to claim 16, wherein said means for generating said at least one force comprises a motor operatively connected to each connecting arm by said means for applying said force, whereby said robotic wrist is actuated by selectively operating at least one connecting arm or a combination of simultaneous movements of at least two of said connecting arms that
10 cause it to rotation with respect to a determined plane.
18. Device according to claim 16, wherein each transmission means of the force is operatively connected to the respective motor by a pulley
15 connected to the axis of the motor same.
19. Device according to claim 18, wherein each pulley is mounted on a bearing and is associated to a resilient means to it co-axial suitable for allowing the pre-tensioning of said means for applying said force.
- 20 20. Device according to claim 18, wherein said motors are associated to sensors of position suitable for determining the position of said robotic wrist and/or of said connecting arms.
21. Device according to claim 15, wherein said motors are
25 operatively connected to said pulleys by a releasable connection.
22. Device according to claim 21, wherein said releasable connection between said motors and said pulleys is effected by means of clutches.
- 30 23. Robotic wrist according to claim 1, characterised in that it is used as distal element for mininvasive surgical operations with feedback force.